HIGH-RESOLUTION SEISMIC SURVEYING FOR NEOGENE-QUATERNARY SEQUENCE STRATIGRAPHY, NORTHERN CALIFORNIA CONTINENTAL SHELF AND UPPER SLOPE, IN SUPPORT OF STRATAFORM

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LONG-TERM GOALS

This project is a component of ONR's STRATAFORM program, the goal of which is to link short-term (i.e., acting over hours to weeks) biological and physical processes affecting sedimentation ("event stratigraphy") to the sequence stratigraphy and facies architecture of the preserved record. STRATAFORM consists of three interrelated projects whose goals are to study: 1) shelf sediment dynamics and the development of lithostratigraphy, 2) slope geological processes and resultant geomorphology, and 3) stratigraphic sequences resulting from shelf and slope sedimentation. High-resolution multichannel seismic (MCS) data collection, described below, forms the core of the third project, but the data also form part of a multi-faceted approach that ties all three projects together.

SCIENTIFIC OBJECTIVES

Specific objectives include: 1) origins of sequence stratigraphic architecture in an environment characterized by high rates of sediment supply, 2) tracking the history of northward sediment dispersal from the Eel River, 3) morphologies and evolution of slope canyons, and 4) history of the Humboldt Slide.

APPROACH

STRATAFORM participants are documenting the stratigraphy of the continental shelf and slope of the Eel River Basin, northern California margin, at a variety of spatial scales (lateral and vertical) and in three dimensions (3-D). The key to this entire effort is the collection of "nested" geophysical and geological data, through use of a variety of tools whose individual temporal and spatial scales overlap to form a wide-ranging continuum of measurements.

WORK COMPLETED

High-resolution 2-D MCS profiles were collected from the outer shelf to slope, offshore Eel River Basin jointly by the University of Texas Institute for Geophysics (UTIG) and Lamont-Doherty Earth Observatory (L-DEO) in July - August 1996. The seismic system, developed and owned by L-DEO, included a 48-channel I.T.I. streamer, 45/45 cu. in. G.I. air gun and OYO DAS-1 recording system. A backup Geco streamer was used for part of the survey. The survey was designed to image stratal geometries at a scale intermediate between those of the existing very-high-resolution (500-3500 Hz) Huntec deep-towed seismic profiles and commercial MCS data, fulfilling the STRATAFORM goal of providing "nested" seismic coverage (several Huntec and JEBCO lines were duplicated). The seismic grid surveyed consists of 84 lines (~2200 km; Figure 1). Line spacings vary, but a spacing of 800 m was maintained, where possible, in both dip and strike directions. Such dense coverage was necessary to provide the 3-D stratigraphic perspective mandated by STRATAFORM. Vertical resolution is ~5m. Data processing is being shared by UTIG and L-DEO (L-DEO P.I.: G.S. Mountain). UTIG has so far processed 26 out of its 41 lines to the stage of post-stack migration. Interpretation is limited to general observations until the entire grid has been processed and loaded into our GeoQuest seismic interpretation software package.

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RESULTS

During sea-level lowstands, part of the shelf was exposed, as indicated by a pair of large, buried channels, up to ~120 m deep and 1 km wide, occurring near the landward end of line 25 (Figure 1). These features may represent crossings of a single, meandering channel, possibly related to Eel River drainage.

Slope channels are of at least two distinctive types (Figure 2). 1) Shallowly buried (~40 m) aggrading gullies, ~20 m deep, are spaced at 300 - 600 m intervals. Cycles of erosion alternate with periods of draping during which gully morphology is retained (Field et al., 1996). Sequence stratigraphic interpretation may confirm whether the erosional episodes occur during periods of low sea-level. 2) Northward of the aggrading gullies are larger buried channels, or canyons up to ~120 m deep and 1 km wide. These channels are erosional and exhibit lateral migration and erosion of fill by subsequent channeling.

The new MCS data support the hypothesis that strike-parallel ridges within the Humboldt Slide zone are structural features related to slope failure rather than bedforms (Gardner et al., 1996). The data reveal what may be earlier, buried failure surfaces, with high-amplitude seismic reflections, possibly indicative of trapped gas-charged fluids, immediately landward of the buried headwall scarps.

IMPACT/APPLICATION

The MCS data: 1) fill the gap in seismic resolution and depth of penetration between existing data sets to provide fully "nested" coverage, 2) link outer shelf and upper slope stratigraphic regimes, and 3) allow development of models that will determine the transfer functions between modern sedimentary processes and stratigraphic preservation.

TRANSITIONS

Mobil has shown interest in processing some lines in order to assist with multiple removal. In addition, we have provided data to Dr. Frank Boyle of the University of Texas Applied Research Laboratory for analysis of phase and frequency.

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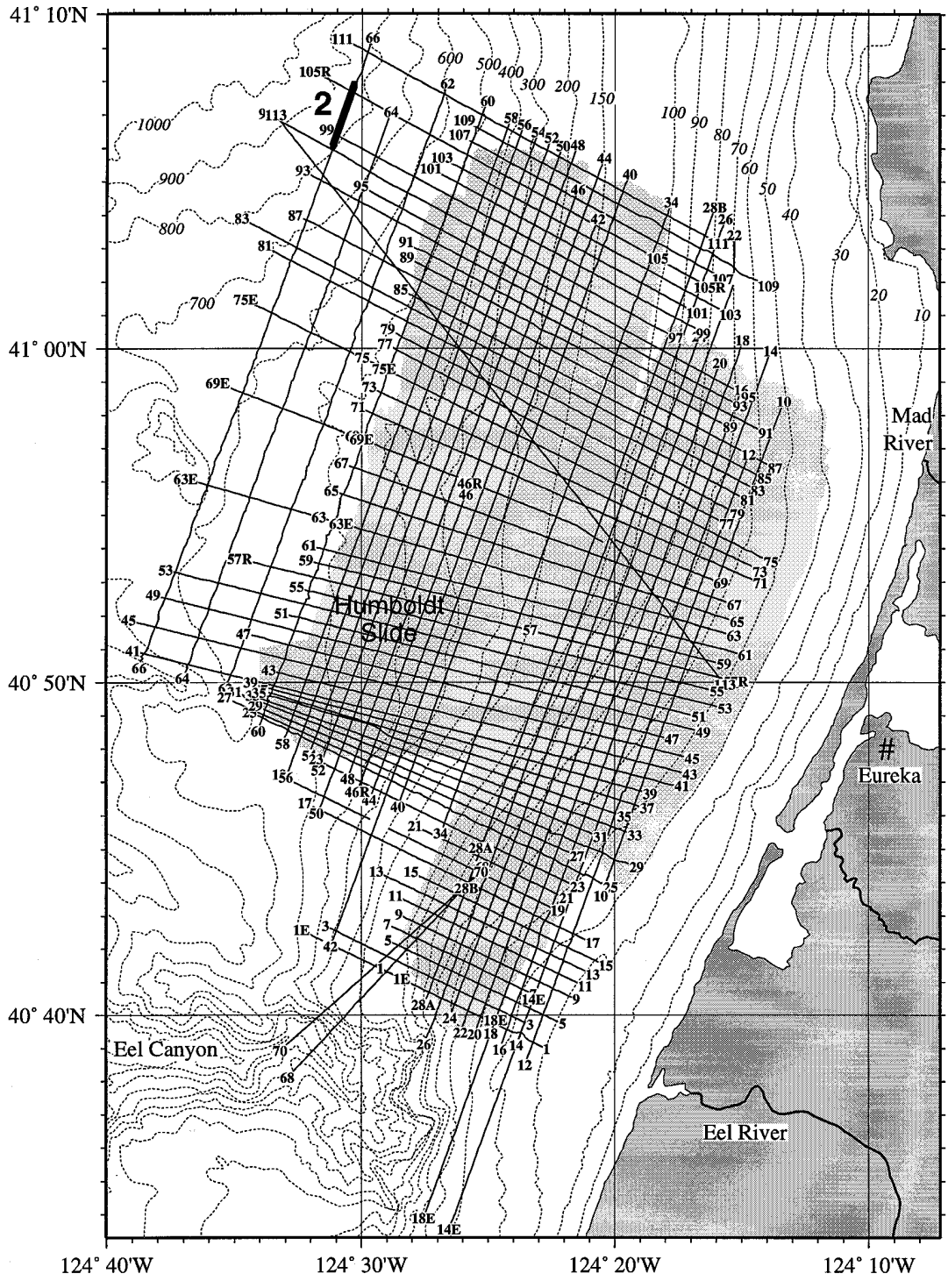

Figure 1. Survey track showing numbered MCS lines collected by R/V *Wecoma* during STRATAFORM high-resolution MCS operations. UTIG and L-DEO are each responsible for processing half of the data: each institution has a subset of the data comprising roughly alternating lines of the grid displayed here. The shaded pattern notes the region of STRATAFORM swath bathymetry/backscatter data acquired by L. Mayer and J. Goff during summer 1995. Profile segment displayed in Figure 2 (line 66) is highlighted. Bathymetry is in meters.

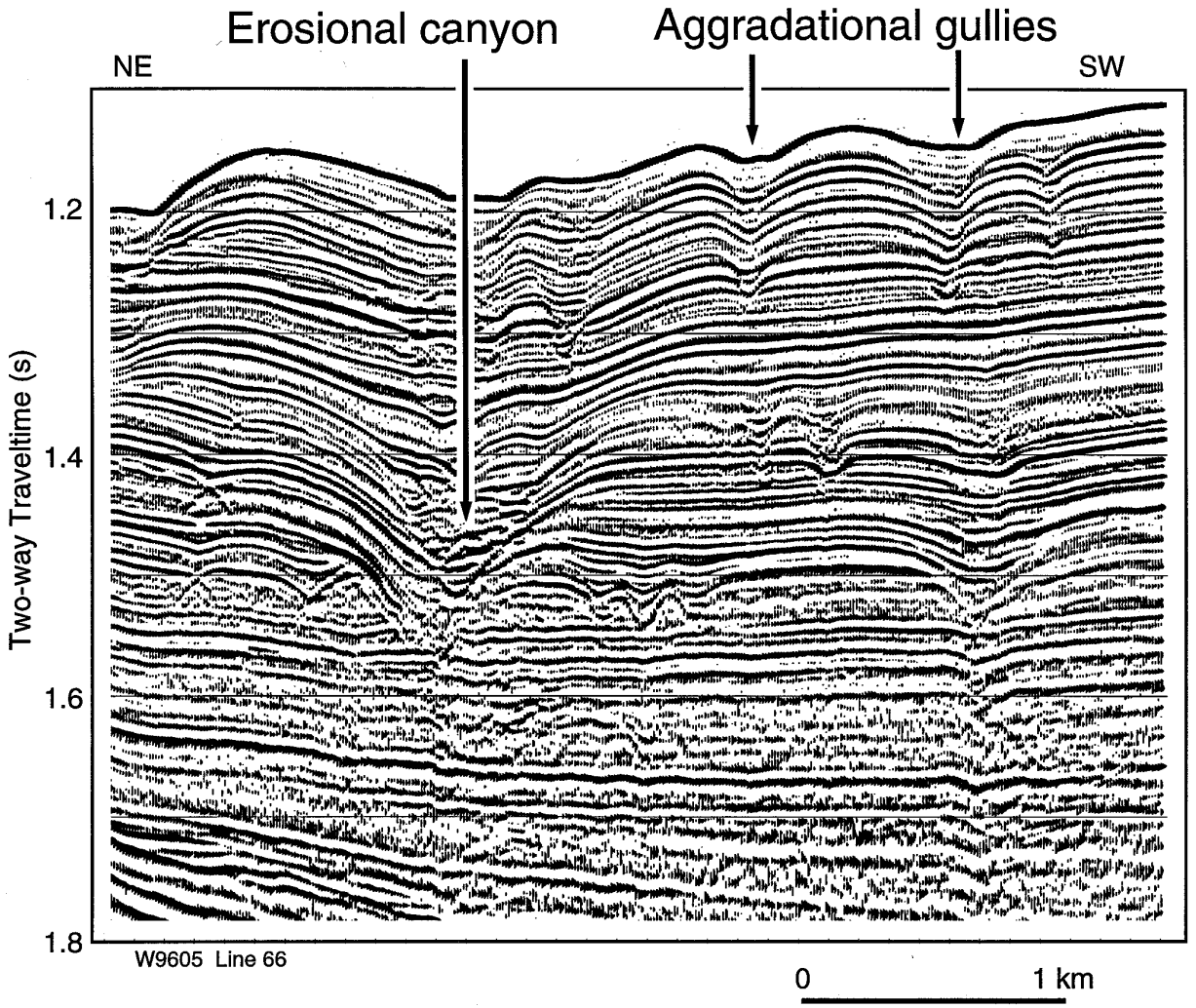

Figure 2. High-resolution MCS line 66 across the lower slope. Two types of channels have existed on the lower slope: 1) shallowly buried aggrading gullies have occupied fixed locations; 2) larger erosional canyons have migrated laterally. See Figure 1 for location.